

## REMARKS

Claims 1-36 are pending. During prior prosecution, the Examiner rejected all claims under 35 USC§ 103 as being unpatentable over Voelskow et al. (U.S. Pat. No. 4,467,034, hereinafter "Voelskow"), in view of Hammond (WO 95/32301, hereinafter "Hammond") and Walkup et al (U.S. Pat. 5,252,473, hereinafter "Walkup").

Applicants have herein cancelled claims 1-36 and have added new claims 37-68.

Support for the amendments may be found throughout the specification, e.g., at pages 5-9 and Examples 1-4 as well as previously pending claims. The amendments to pages 5, 7 and 8 of the specification are for the purpose of providing a clear counterpart for the amendment to the claims. No new matter has been added.

More specifically, new claim 37 corresponds to previously pending claim 1. Slightly different wording has been introduced such as the reference to a "protonated" cation exchanger, which can readily be understood to correspond to the cation exchanger which is at least partially in the acid form. Furthermore, the recital in step (b) as to reacting the cation exchanger to convert it to its at least partially acid form has been more simply referred to as regenerating said cation exchanger. Furthermore, it is obviously more appropriate to use the terminology that the second product resulting in step (b) is "a basic form of said cation of said lactate salt" since technically speaking the ammonia gas formed as per lines 1 and 2 of page 8 of the description does not "comprise a cation of said salt" (the ammonium lactate salt). New independent claim 40 corresponds to an embodiment of the invention described

at page 7 lines 14-22 of the description. Said process differs from that of new claim 37 in that in step (b) an acidic salt is used to regenerate the protonated cation exchanger and to neutralize the acidic salt. One then heats the neutralized salt so as to decompose it thermally to form a second product, which is a basic form (e.g. ammonia) of said cation of said lactate salt, and to regenerate the acidic salt of the di- or triprotic acid. The first full paragraph on page 7 has been amended to provide counterparts for the language in new claim 40 as well as to provide a counterpart for the language of new claim 41 in which the metal M as used in the formulas in lines 4 and 3 from the bottom of said paragraph would be construed to be an alkali as generic to sodium as specifically illustrated. The reference to a water-immiscible cation or anion exchanger in claims 37 and 40 has been removed as superfluous in the case of solid exchangers. However, reference to the water-immiscibility has been incorporated in claims 43 and 49 dealing with liquid cation and anion exchangers. New claim 62 is based on the disclosure at page 8, lines 11-13 as to the thermal hydrolysis of the salts of the cation exchanger and on to presently pending claim 24.

The object of the invention is to recover lactic acid from aqueous solutions containing lactate salts, such as obtained from fermentation baths without the problematic formation of salt by-products, such as described at page 4, lines 1 and 2 of the description. For this purpose a protonated cation exchanger is used to acidulate the lactate salt. However, the process of new claim 37 is carried out so that the regeneration of the cation exchanger, which has cations from the water-soluble lactate salt thereon, is caused to yield a second product which is a basic form of the cation of

the lactate salt. According to the specific embodiment of claim 66, the second product is ammonia, which is a basic form of the ammonium cation bound to the cation exchanger as from the contact with the aqueous solution of ammonium lactate. Claim 39 also applies to this embodiment. A further possibility covered by new independent claim 37 is the thermal hydrolysis of alkali and alkaline metal salts as covered by new claims 62 and 63 and as described at lines 11-13 of page 8 of the description.

In accordance with the aspect of the invention defined by new claim 40 and based on page 7, lines 14-22 of the description, the cation exchanger is regenerated by contacting it with an acidic salt or a di- or triprotic acid to neutralize the acidic salt, the resulting neutralized salt containing a cation derived from the lactate salt and an anion of said neutralized acidic salt. The neutralized salt, such as ammonium sulfate, is heated in step (c) to yield the second product which is a basic form of the cation of the lactate salt and to regenerate said acidic salt of said di- or triprotic acid, useful for subsequent reuse.

In all of the above possibilities a basic compound is formed which can be utilized for neutralizing the fermentation bath producing the aqueous solution of the lactate salt.

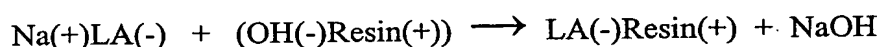
### Rejections under 35 U.S. C. § 103

During prior prosecution, the Examiner rejected all claims under 35 USC § 103 over Voelskow in view of Hammond and Walkup. In particular, the Examiner asserted that it would have been obvious for one of skill in the art to have used Hammond's anion exchanger followed by Voelskow's cation exchanger, along with Walkup's hydrolysis, to increase the efficiency of the overall purification process. Applicants respectfully disagree. Proper analysis under § 103 requires consideration of two factors: (1) whether the prior art would have suggested to those of ordinary skill in the art that they should make the claimed composition, and (2) whether the prior art would also have revealed that in so making, those of ordinary skill would have had a reasonable expectation of success. In re Vaeck, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991).

None of the cited references, either alone or in combination, teaches or suggests the presently claimed process. New independent claims 37 and 40 recite a process for recovering lactic acid. In step (a) of both claims, a protonated cation exchanger is contacted with an aqueous solution of a lactate salt. In addition, step (b) of claim 37 and step (c) of claim 40 recite the production of a second basic product during the regeneration of the cation exchanger and the regeneration of the acidic salt of the di- or triprotic acid, respectively. Both claims require the second basic product to be a basic form of the cation of the lactate salt.

Voelskow is directed to the production of D-lactic acid using *Lactobacillus*.

Because the production of lactic acid during fermentation leads to pH lowering of the fermentation broth, Voelskow uses calcium carbonate or sodium hydroxide to buffer the solution and raise the pH to a regime suitable for bacterial growth. If sodium hydroxide is used to raise the pH, sodium lactate is produced. To isolate free lactic acid, Voelskow discloses the use of an ion exchange resin in Ex. 5, col.5: "Na(+)LA(-) solution obtained was led through ion exchange columns which absorbed the lactic acid. As soon as a column was loaded with lactic acid, it was eluted with hydrochloric acid. After regeneration with dilute sodium hydroxide solution, the column could be reused for lactic acid adsorption." (emphasis added). Applicants respectfully assert that an anion exchanger was used to do this, as follows:



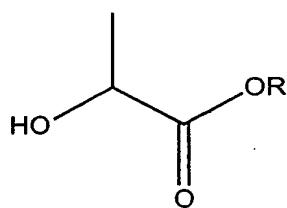
where LA(-) Resin(+) represents an anion exchange resin loaded with LA(-), the lactate anion. HCl treatment was then used to elute HLA and to yield Cl(-) Resin(+). The resin was then regenerated with NaOH to yield NaCl (salt) and OH(-) Resin(+) (regenerated anion exchange resin). As can be seen, at no point does Voelskow teach or suggest either 1) the use of a cation exchanger; or 2) the production of a basic second product derived from the cation of the lactate salt during

the regeneration of the cation exchanger or the regeneration of an acid salt of a di- or triprotic salt which had previously been used to regenerate the cation exchanger. Both 1) and 2) are required limitations of the pending claims. While NaOH is produced in the Voelskow method during treatment of NaLA with an anion exchange resin, and while NaOH is basic and does include the Na(+) cation of the NaLA (sodium Lactate) salt, NaOH is not a "basic second product" according to the claim limitations because it is not produced during the treatment of the cation exchange resin or the neutralized salt of the acid salt, as is required in the pending claims.

Neither Hammond nor Walkup cure the deficiencies of Voelskow. Hammond is directed to the purification of lactic acid by using an anion exchange resin for production of an alkali metal-LA (alkali metal lactate) salt, and then production of HLA from such a salt with a cation exchange resin in acid form. In this process, Hammond discloses using an anion exchange resin to bind LA(-) lactate ion from a feed bioreactor solution (e.g., to result in Resin(+)LA(-)). NaOH is then used to regenerate the anion exchange resin to yield NaLA (sodium lactate, an alkali metal salt of LA) and the regenerated anion exchange resin (e.g., OH(-)Resin(+)). Hammond discloses that the NaLA (sodium lactate) so produced can then be passed through a cation exchange resin in hydrogen form (e.g., H(+)Resin(-)), to yield HLA (lactic acid) and Na(+)Resin(-) (cation exchanger with cations bound). Hammond then teaches (e.g. at page 11, lines 5-9) using HCl to regenerate the cation exchange column to yield the cation exchanger in its acid form (e.g., H(+)Resin(-)). Importantly, however, no basic second product results from such a treatment. Instead,

Hammond's treatment yields NaCl, a neutral salt. Accordingly, Hammond does not teach or suggest, either alone or in combination with Voelskow, the regeneration of a cation exchanger so that a basic second product is formed where the basic second product is a basic form of the lactate salt cation.

Like Voelskow and Hammond, Walkup also does not teach or suggest the present claim limitations. Walkup teaches the conversion of ammonium lactate into lactic acid esters and the subsequent catalytic conversion of the lactic acid esters to HLA (lactic acid) on cation exchange columns. Applicants respectfully note that a lactic acid ester has the following formula;



, where R can be methyl, ethyl, propyl, etc.

Cols. 5-6 of Walkup teach that conversion of ammonium lactate to lactic acid esters occurs through a two step mechanism: decomposition of  $\text{NH}_4^+ + \text{LA}^-$  (ammonium lactate) to  $\text{NH}_3$  and lactic acid; and then reaction of lactic acid with an alcohol (e.g., ROH) to yield a lactic acid ester. Col. 6 notes that the equilibrium constant for the first reaction (to  $\text{NH}_3$  and lactic acid) is very unfavorable, and that one needs to remove  $\text{NH}_3$  with a  $\text{CO}_2$  stream to shift the equilibrium to HLA (lactic acid) production so that the subsequent esterification proceeds.

Walkup discloses that one can recover HLA (lactic acid) from this intermediate lactic acid ester form (see Col. 14, lines 21 and following) by catalytic conversion on a cation exchange column. Importantly, however, Walkup never contacts a solution containing a lactate salt with a cation exchanger in its acid form, as required by the present claims. Walkup teaches contacting a solution containing a lactic acid ester, which is not a salt, with a cation exchange column active as a catalyst in the presence of water. Thus, Walkup does not teach a direct conversion from ammonium lactate of  $\text{NH}_3$  and lactic acid, as its essentially accomplished in the present invention. At no point does Walkup ever suggest combining his first  $\text{NH}_3$  generation step with his cation exchange column - indeed, Walkup only taught an intermediate ester route. Thus, Walkup does not teach or suggest the claimed process. Furthermore, one of skill in the art would have no reasonable expectation of success in modifying Walkup to do such a direct conversion for three reasons: (1) Walkup discloses the very unfavorable equilibrium constant of such a reaction; (2) Walkup teaches using an intermediate lactic acid ester route; (3) The cation exchange column is used as an acid catalyst for the hydrolysis of the ammonium lactate rather than as a cation exchanger.

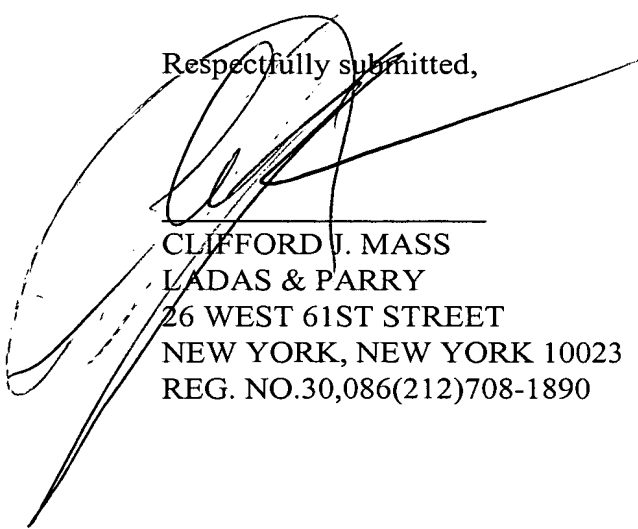
Additionally, Walkup also does not teach the generation of second basic product in connection with the regeneration of a cation exchanger. Applicants respectfully note that Walkup's catalytic conversion using the cation exchange resin in acid form, as disclosed in Col. 14, will yield only a neutral alcohol ( $\text{HOR}$ , where  $\text{OR}$  is from the ester), and not a basic second product. Accordingly, given all of the



above, Applicants respectfully assert that the present claims are not obvious under 35 U.S.C. § 103 given Voelskow in view of Hammond and Walkup.

In view of the above remarks and amendments, it is believed that the Examiner will now appreciate the allowability of new claims 37-68, and favorable action in this regard is respectfully requested. If the undersigned can be of assistance in resolving outstanding matters, it is requested that the Examiner contact him at the telephone number indicated below.

Respectfully submitted,



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